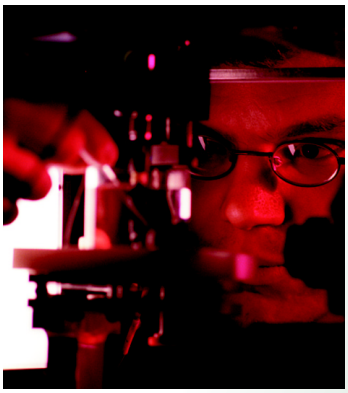
Materials

Scanning probe microscopy techniques are being developed and applied to investigation of fundamental corrosion and biologically assisted corrosion mechanisms.



The Materials organization is improving understanding of the relationships between processing and materials properties, and developing new characterization techniques for metals, ceramics and composite materials. Areas of research include nanocomposite and particulate materials development, fracture mechanics, advanced ceramics, engineering, biocorrosion of metals utilizing new scanning probe microscopy techniques, and computational materials science and materials processing.

The staff of 25 focuses on developing new materials and processes with improved performance, and developing new methods to characterize and predict the behavior of materials. Researchers use a broad range of processing techniques including plasma, powder metallurgy, spray forming, and rapid solidification to make or modify advanced materials. A portion of R&D focuses on microstructural control to cost-effectively provide enhanced properties and meet performance specifications.

INEEL materials scientists have extensive capabilities in modeling, process diagnostics, and materials characterization. Characterization techniques include atomic force and scanning electrochemical microscopy, high-resolution (20 micrometers) moir´e interferometry, and microtopography in addition to routine mechanical property and microstructural characterization methods.

The Materials organization has a strong science focus, with emphasis on peer-reviewed publication of research. Novel instruments, processes and products are the natural progression of such work, enabling strong, applications-oriented research for government and industry partners.

Nanocomposites

Researchers are developing uniform nanostructured bulk materials through self-assembling solid state transformations. Staff has extensive expertise in alloy design and processing using melt spinning and gas atomization to produce rapidly solidified alloys. Nanostructured materials exhibit dramatically improved mechanical properties such as strength and hardness in steels, and magnetic properties such as coercivity and remanence in rare earth transition metal magnets.

Particulate Materials

Researchers are using particulates to develop consolidated ceramic, intermetallic and composite materials with improved performance properties. Researchers are also using the equal channel angular extrusion process for powder consolidation and thermomechanical processing for metallic materials. They are investigating elemental powder reaction synthesis to form near-net shape intermetallic alloys suitable for aggressive atmospheres at elevated temperatures.

Fracture Mechanics

Research engineers are conducting fundamental fracture studies of materials ranging from brittle geo-media and ceramics to very ductile metals containing weldments and using a variety of unique technologies. INEEL developed

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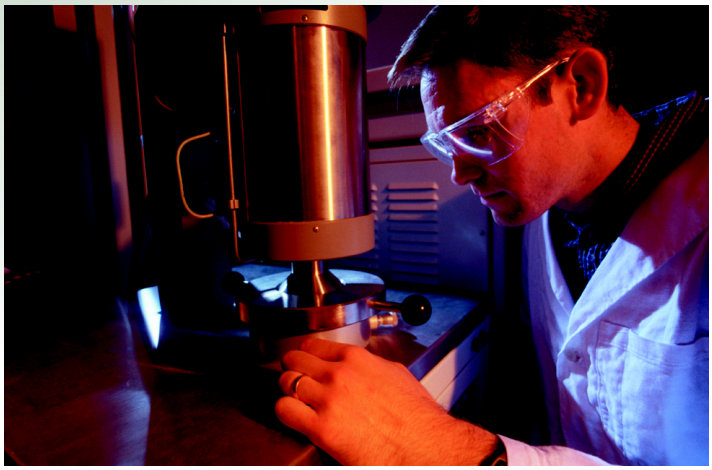

A laser flash thermal diffusivity system is used to characterize physical properties of multi-layer materials.

Idaho National Engineering and Environmental Laboratory

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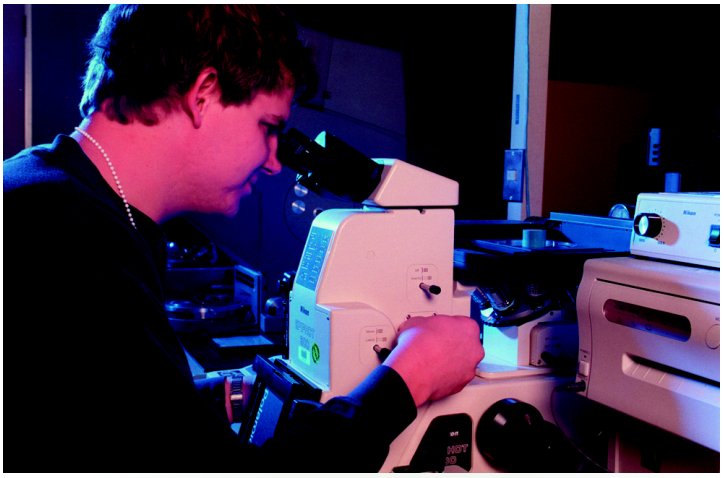

Optical metallography characterization of metals and ceramics provides basic information on processing microstructure relationships.

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a microtopography system that enables fracture surface mapping of test specimens and structures, and reconstruction and analysis of the originating fracture process. In addition, staff is developing instruments and technology to monitor the health of structural components during operation, such as pressure vessels and piping.

Advanced Ceramics

Researchers are developing advanced ceramic materials with graded microstructures to enhance desired physical and chemical properties for specific applications using advanced methods such as electrophoretic deposition combined with reaction bonding. Staff is developing ionic conducting ceramics for use in energy conversion or storage devices such as fuel cells, separation membranes, batteries, and sensors as well as advanced compositions that result in enhanced electrochemical performance (e.g. oxygen ion or proton conduction). Staff is reducing production costs through new fabrication technologies. And researchers are investigating organometallic precursors for thin ceramic films, including nanocrystalline ceramics with enhanced transport properties.

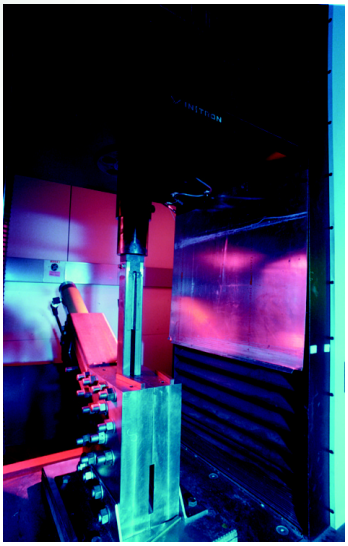
Computational Materials Sciences and Processes

Researchers are developing computational models for a wide range of applications to increase our understanding of diverse materials processes such as friction stir welding, supercritical fluid dynamics, dry flow field flooding, solid oxide fuel cells, and the complex dynamics of fluids and solids. In the area of subsurface science, researchers are developing multiphase mixture, constitutive, and stochastic models to study fluid flow and transport properties of fractured and porous rock. Researchers are developing basic numerical methods for multiphase mixtures, new pressure-based computation fluid dynamic methods, and meshless "particle" methods. In other work, staff is applying numerical methods to simulate crack propagation in coatings, geological materials and weldments.

Biocorrosion

Microbial populations' effects on corrosion on spent nuclear fuel storage containers are being determined. This research area is highly interdisciplinary, involving microbiological techniques to isolate, culture, and identify bacteria species, and fluorescence-based imaging techniques to spatially correlate microbes with localized corrosion areas. Materials science is used to determine the influence of the alloy microstructure on the observed corrosion processes.

The Materials organization can support a broad range of collaborative research with other national laboratories and universities, and fundamental or applied research to meet industry customer needs.



Massive amounts of strain are imparted to alloys without permanent shape change using equal channel angular extrusion.

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